IFS alternative operations impact

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All calculations are for SNR = 10 assuming
SPC Phase B coronagraph table & 20190130 sensitivities
V=5 star, planet at 240 mas

MUF=1 integration time ON TARGET. No overheads or ref star

Delta mag at 730nm	IFS int [hr]	Amici int [hr]	2% NB int [hr]	2.5% NB int [hr]	5% NB int [hr]
18.25 = req	3.6	2.3	1.9	1.4	0.7
19	11	6.2	5.1	3.8	1.7
20	55	29	23	17	7
21	310	160	120	90	36
21.5 = RV	800	400	300	210	84

June 10, 2019 version of Bijan's exposure time calculator

MUF=1 SNR=10 integration time ON TARGET. No overheads or ref star

Delta mag at **730nm**	IFS int [hr]	Amici int [hr]	2% NB int [hr]	2.5% NB int [hr]	5% NB int [hr]
18.25 = req	3.6	2.3	1.9	1.4	0.7
19	11	6.2	5.1	3.8	1.7
20	55	29	23	17	7
21	310	160	120	90	36
21.5 = RV	800	400	300	210	84

- Amici integration time is less than IFS
- 7x2% NB filters
  - Cannot detect RV planet.
  - Could meet requirement (TODO: calc/sum for all filters. *Maybe*: check REQ performance level?)
- 2x2.5% + 5% NB filter
  - Can probably detect RV planet (TODO: get actual dmags in proposed filters and recalc)

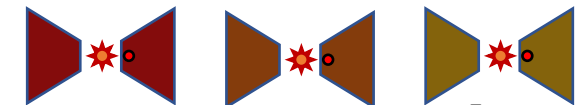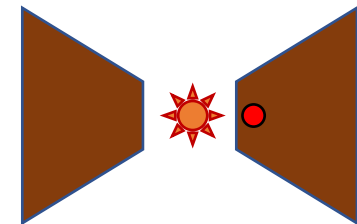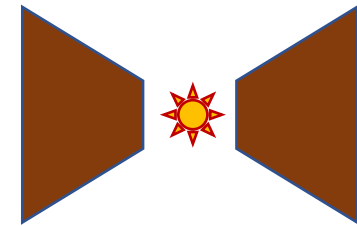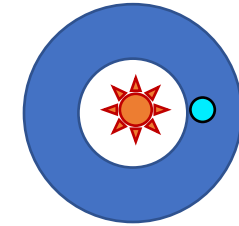June 10, 2019 version of Bijan's exposure time calculator

IFS concept of operations

- Pre-image planet in Band 1 imaging to determine location
  - Use to schedule spectroscopy, minimum 1 week wait

- Dig the dark hole in IFS mode on a bright *reference* star
  - WFC using IFS itself

- Long integration on *reference* star for RDI library

- Acquire *target* star & align with coronagraph

- Long integration on *target* star
  - Keep WFC solution from reference star

- Return to *reference* star for WFC touchup & reference images
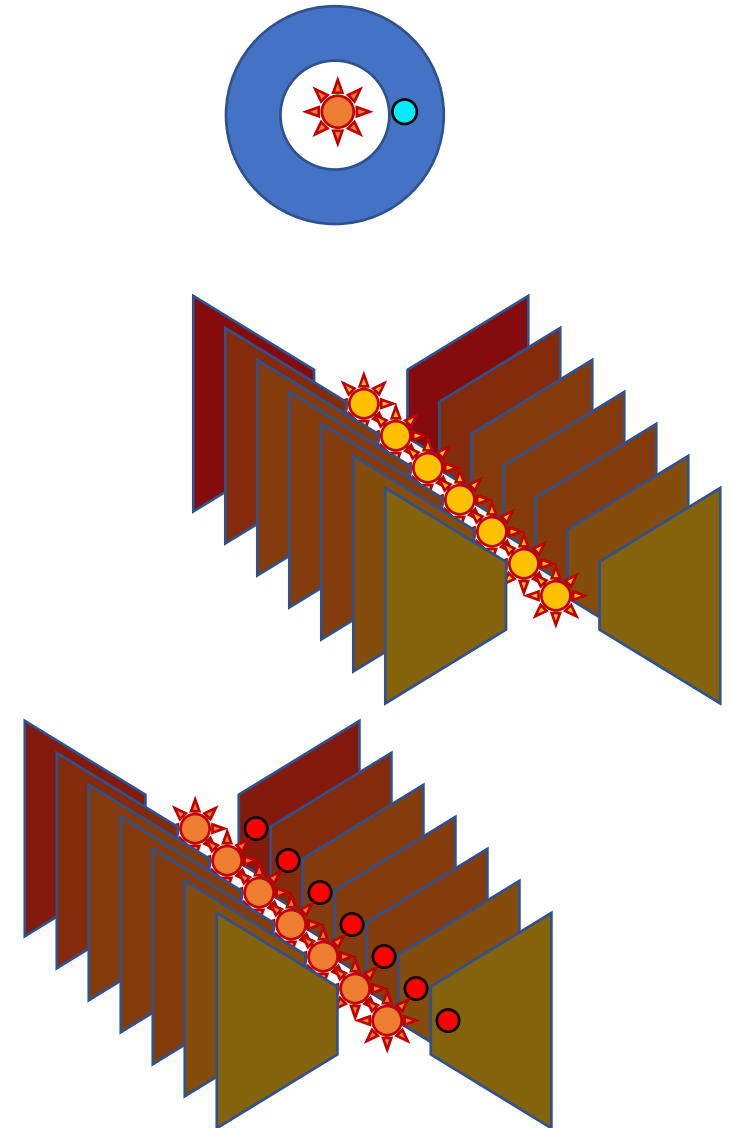
Narrowband filter concept of operations

- Pre-image planet in Band 1 imaging to determine location
  - Use to schedule spectroscopy, minimum 1 week wait

- Dig the dark hole in imaging mode on a bright *reference* star
  - WFC uses science filter itself if ≤ 3.5%, otherwise sub-bands are needed

- Long integration on *reference* star for RDI library

- Acquire *target* star & align with coronagraph

- Long integration on *target* star
  - Keep WFC solution from reference star

- Return to *reference* star for WFC touchup & reference images
- Repeat procedure <u>sequentially</u> for each NB filter (≥3 filters)
  - Minor consequence: temporal variability of speckles vs. planet are difficult to distinguish

Prism concept of operations: part 1

- Pre-image planet in Band 1 imaging to determine location
  - Use to schedule spectroscopy, minimum 1 week wait

- Dig the dark hole in imaging mode on a bright *reference* star
  - WFC uses 3-3.5% sub-bands. Expected to meet 30hr WFC time requirement.
  - WFC needs full image information => no slit or prism in the path
  - More filter slots needed to new accommodate WFC filters

- Align slit over area of interest on *reference* star
  - Match slit location on target star
  - Tricky.

- Long integration on *reference* star for RDI library

- Spectrum of un-occulted *reference* star
  - Use FSM to place star in slit? Or satellite spots/streaks?

...
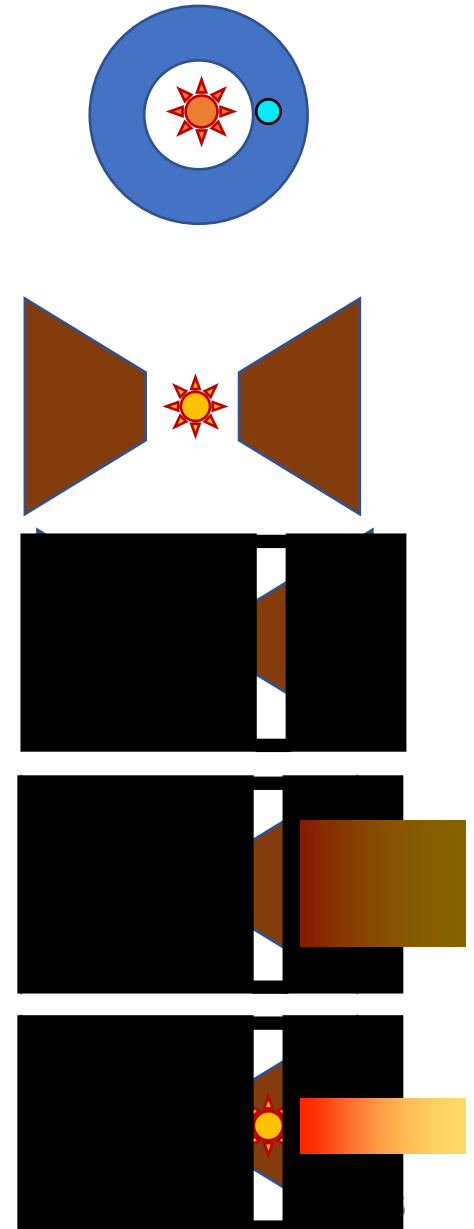
Prism concept of operations: part 2

- Acquire *target* star & align with coronagraph
  - Remove slit and prism for alignment

- Re-Align slit over area of interest

- Long integration on target star
  - Keep WFC solution from reference star

- Spectrum of un-occulted *target* star
  - Use FSM to place star in slit? Or satellite spots/streaks?

- Return to reference star for WFC touchup & reference images
  - Repeat slit acquisition procedure each time

Slit alignment tolerance

Neil Zimmerman
John Debes
Derek Barnes
Hong Tang
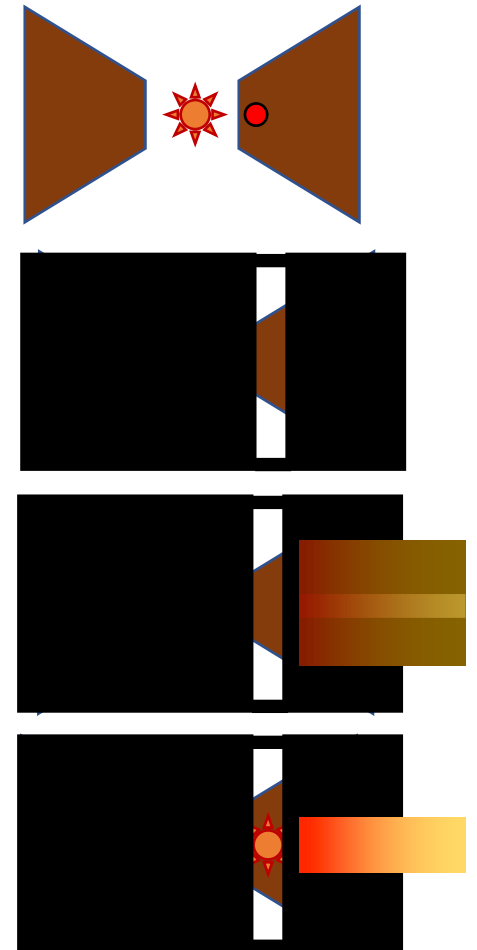
- 2nm wavelength calibration planet-to-slit alignment tolerance

- 0.5px =
  - < 1.5nm wavecal error over all Band 3
  - < 5% slit flux loss at red end of Band 3
  - **10mas** ~ 1/15 slit width

- **PAM req. precision meets alignment needs**
  - **Initial** placement RMS = 10 um = 21 mas. Does **NOT** meet wavecal need
  - **Fine adjustment** RMS ~ 1um ~ 2 mas. **DOES** meet wavecal need
    - **15 min settling time** required before fine adjustments
  - Bench deformations will move PAMS & DICAM < 3mas (worst case).

- Other image motion sources TBD – help?
  - What are req's on image drift relative to PAMs and DIAM due to motion of mirrors & bench? Image motion must be smaller than PAM precision

Slit fine alignment adds ~30min overhead

- **Wait 15 min** for PAM to settle

- Determining slit position *(needs more thought…)*
  - **How to illuminate?** Out of band (see below)? Remove filter entirely? Satellite spots/streaks (<1E-7)? Nudge star off-center under mask?
  - Can we just fit apparent edges? Or do we need to cross-correlate with a pattern?
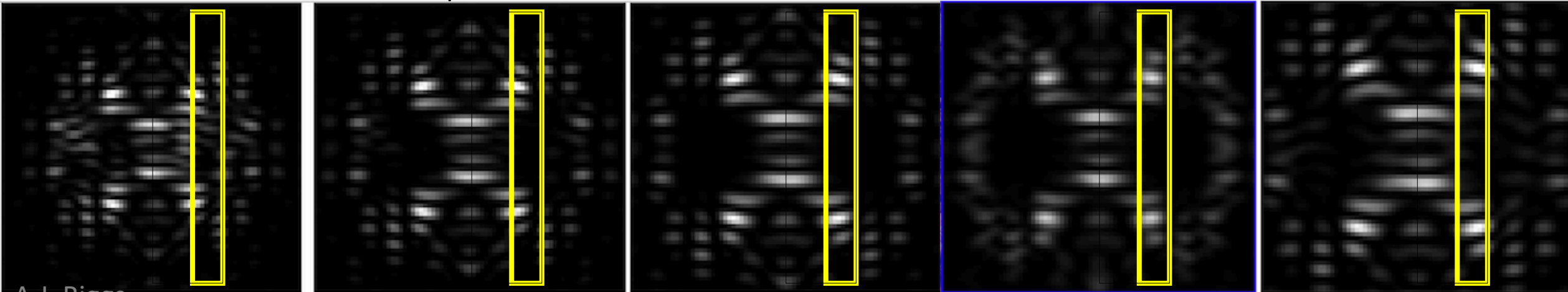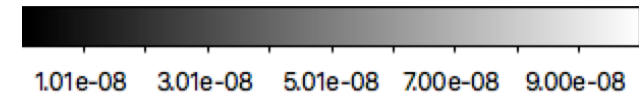 - **15?? min** required to find & iterate on slit location. **Automated?**

575nm 3.3%
10^-7 ~ 5min exp

Halpha 1%

730 nm 3.0%

730 nm 15%

825 nm 3.3%

1.01e-08   3.01e-08   5.01e-08   7.00e-08   9.00e-08

A.J. Riggs

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Amici <u>extra</u> overhead compared to IFS assuming OS6-like (4x2hr blocks on target + 1x2hr block on ref)
- Target star: t/2*0.5hr   - Reference star: t/4 * 0.5hr
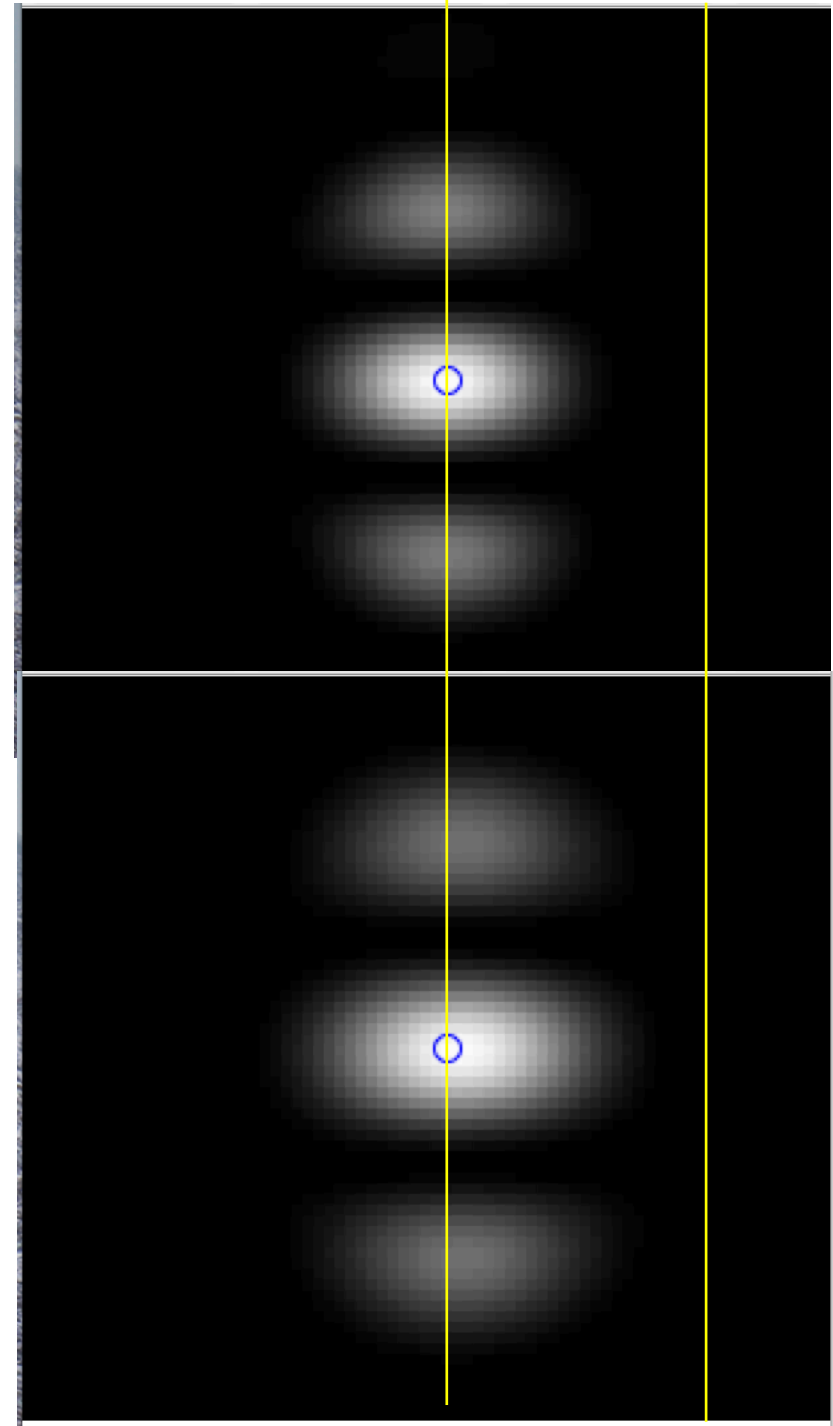- 400hr on target => <u>extra</u> 150hr overheads for slit alignment Still faster than IFS.

Modeling of PSF distortion near IWA and OWA required

At red end, more of PSF emerges from behind occult0r
=> appears shifted

Δ ~ 0.2 λ/D
~ 10 mas
~ 2 nm

John Krist
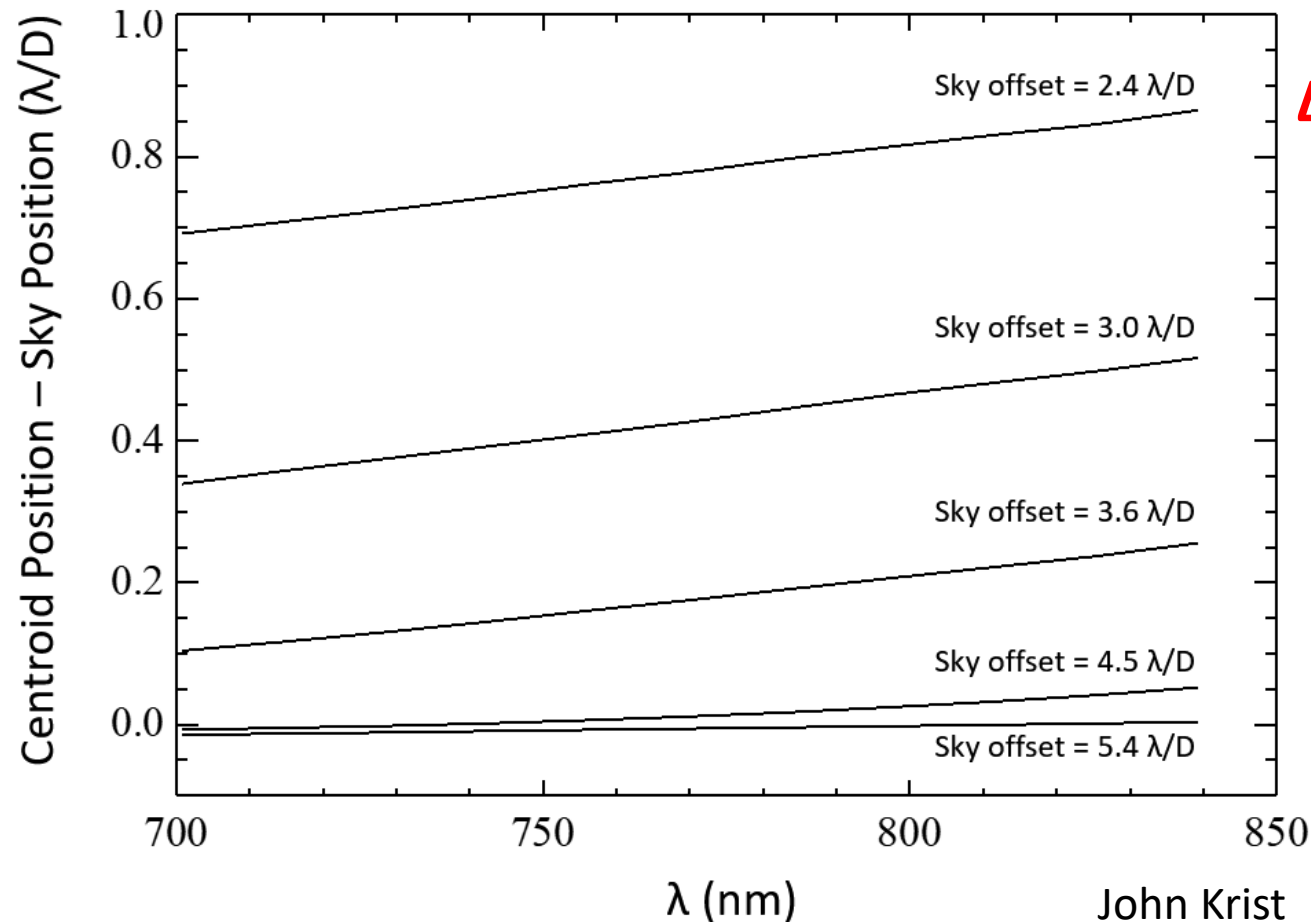
Preliminary conclusions

- Slit+prism
  - likely to meet L2 requirement *if* OK to have R < 50 at red end
  - likely to match or exceed IFS sensitivity for equal amount of *clock* time
    - target + reference + overheads
    - Slit alignment is tricky and time-consuming
    - Can slight alignment be automated?
  - Space for new WFC filters needed

- Narrowband filters
  - Simplified operations compared to prism
  - 7 x 2% filters may be able to meet L2 requirement but *can't do better*
    - TODO: evaluate with MUFs?
  - 2 x 2.5% + 1 x 5% filter can probably detect CH4 in an RV planet in <1000hr
    - does NOT meet L2 b/c it does not span 15% bandwidth or achieve R=50